SANTA MONICA BAY SHORELINE MONITORING
MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) REPORT
(June 1, 2013 – May 31, 2014)
Monitoring and Assessment by the City of Los Angeles Environmental Monitoring Division

I. INTRODUCTION

Increasing population and ongoing urban developments within the Santa Monica Bay area have the potential to create significant impacts on beach water quality. Human activities, including, but not limited to, car washing, landscape irrigation, neglecting to pick up and properly dispose of pet waste, homelessness, improper disposal of car oil, illicit connections, and leaky septic tanks, contribute various pollutants that are washed into local waters through storm drains and urban runoff especially during rain events. These are considered as point and non-point sources of pollutants. These sources contain flows that are untreated. Significant improvements have been made in treating point source flows from wastewater treatment plants and industrial facilities. The Environmental Protection Agency (EPA) has estimated that non-point sources of pollution are now the single largest cause of deterioration of water quality (Ohio State University 2009; Dojiri et al., 2003). Storm drains have been identified as potentially large sources of bacteria discharged to receiving waters around the country. This is particularly true in California, where sanitary sewer and storm drain sewer systems are separate, and storm drain discharges are not treated before they discharge across the beach directly into the water-contact zones (Schiff and Kinney 2001).

The EPA established a municipal storm water management program known as the Municipal Separate Storm Sewage System (MS4) Program that is intended to improve the nation's waters by reducing the quantities of pollutants that urban runoff and storm water pick up and carry into the storm water systems from normal or routine urban activities and during storm events. An MS4 is a conveyance system made up of catch basins, curbs, gutters, ditches, and storm drains owned by a state, city, county, town, or other public body, that is designed to collect or convey storm water and urban runoff to waters of the United States (CRWQCB 2001). Unless diverted to treatment plants or other treatment facilities, these discharges are untreated, carrying pollutants to local water bodies. The City of Los Angeles (CLA), as a co-permitee of the Los Angeles County MS4 Program, discharges storm water into local waterways. The permit for the MS4 Program requires the City to design a storm water management program that reduces the discharge of pollutants to the maximum extent practicable, that protects water quality, and that satisfies the water quality requirements of the Clean Water Act (CRWQCB 2001).

The Santa Monica Bay Beaches were designated as impaired and included on California's 1998 Clean Water Act 303(d) list of impaired waters due to excessive amounts of coliform bacteria. The California Regional Water Quality Control Board, Los Angeles Region (Regional Board) released a first draft of the Santa Monica Bay Beaches Bacterial TMDL (SMBBB TMDL) on November 9, 2001. Regional Board staff bifurcated the SMBBB TMDL into two TMDLs, one for dry-weather and one for wet-weather. Both the SMBBB Dry- and Wet-Weather TMDLs were approved by EPA in June 2003 and became effective on July 15, 2003. The SMBBB TMDLs divide the year into three separate periods for compliance purposes: summer-dry weather (April 1 – October 31), winter-dry weather (November 1 – March 31), and wet weather. A single Coordinated Shoreline Monitoring Plan (CSMP) was developed by the TMDL's responsible agencies to comply with the monitoring requirements of both the Dry- and Wet-Weather TMDLs; monitoring of SMBBB TMDL compliance monitoring stations began November 1, 2004. In addition to bacterial monitoring sites, the CSMP established multiple shoreline observation sites for dry-weather flow observations. One year from the initiation of the monitoring program, the Regional Board was to evaluate the accumulated flow observation data to determine whether any of the observation sites warranted inclusion to the list of compliance monitoring sites.

Four years after the effective date of the TMDLs, the Regional Board was to have re-opened the TMDLs to reconsider certain provisions based on new data, including waste load allocations. Waste load allocations are the number of sample days at a shoreline sampling site that may exceed a single-sample target. Waste load allocations are expressed as allowable exceedance days because the bacterial density and frequency of single-sample exceedances are the most relevant to public health protection (CRWQCB 2004).

Current state water quality standards require the use of bacteria as indicators of human fecal contamination. Their presence in water, especially fecal coliform/*E. coli* and enterococci, is considered to be an indication of recent fecal contamination, which is the major source of many waterborne diseases (Csuros and Csuros 1999).

The SMBBB TMDLs establish multi-part numeric targets based on three bacteriological analytical parameters: Total coliform density, fecal coliform/*E. coli* density, and *Enterococcus* density, with density reported in bacterial counts per 100 milliliters. The targets instituted by the TMDLs have been established based on the Los Angeles Basin Plan water quality objectives for water contact recreation (REC-1) beneficial use for marine water and are equivalent to the State bacteriological standards pursuant to Assembly Bill 411. Basin Plan objectives include both single-sample limits and geometric mean limits (Table 1). EMD evaluates and reports data relative to marine water REC-1 water quality standards for bacterial densities.

Table 1. Los Angeles Basin Plan bacteriological water quality standards (REC-1)

Single-sample Limits shall not exceed	**Rolling 30-day Geometric Mean Limits shall not exceed**
10,000 total coliform bacteria/100 ml; or	1,000 total coliform bacteria/100 ml; or
400 fecal coliform/*E.coli* bacteria/100 ml; or	200 fecal coliform/*E.coli* bacteria/100 ml; or
104 *Enterococcus* bacteria/100 ml; or	35 *Enterococcus* bacteria/100 ml
1,000 total coliform bacteria/100 ml, if the ratio of fecal/total coliform exceeds 0.1	

Monitoring indicator bacteria, currently, is one of the most efficient means of predicting the presence of pathogens in marine waters. These indicators are used because the methods for their detection are comparatively rapid, relatively inexpensive, and easy to perform. The current quantification method used by CLA to quantify indicator bacterial densities for all SMB shoreline stations, the chromogenic substrate method (CS), depends on approximately an 18 to 24-hour incubation and bacterial growth period to obtain results. The turnaround time of this and other currently employed, culture-based, quantification methods does not allow for early, same-day notification of potential public health risks and identification of the source of contamination.

As part of the Annual Report for the MS4 NPDES Permit, CLA had been submitting a Santa Monica Bay Shoreline Monitoring Annual Report that included water quality analysis at eighteen (18) MS4 monitoring stations over the period from July 1 through June 30. The time between the end of the reporting period date June 30 and the submittal deadline was not sufficient for lab analysis, data compilation, data analysis, and preparation of the final report. CLA requested and received approval from the Regional Board to modify the reporting period from July 1 through June 30 to **June 1 thru May 31**.

Starting June 1, 2013, stations S13 through S18 are monitored by MS4/SMBBB TMDL CMP Jurisdictions 5 and 6 (CRWQCB, 2012). This report summarizes the City of Los Angeles EMD's Santa Monica Bay shoreline bacteriological data for the Reporting Year 2013-2014 (June 1, 2013 through May 31, 2014).

The Santa Monica Bay shoreline bacterial data collected by CLA are reported daily to the Los Angeles County Department of Public Health (LACDPH). Subsequently, LACDPH takes steps (such as posting health hazard warning signs for beach users) to notify beach goers whenever an exceedance of bacterial standards occurs.

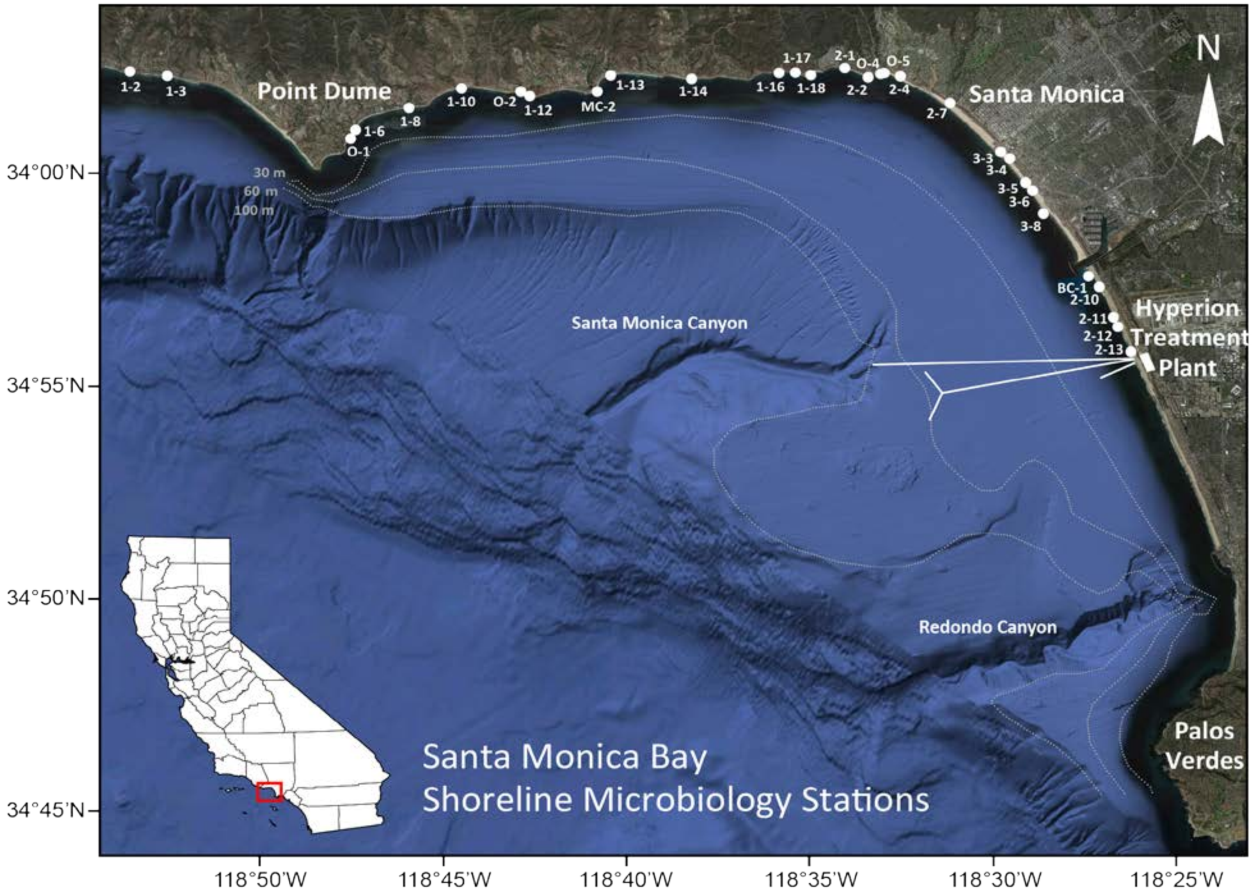


Figure 1: Map of EMD monitored shoreline sampling locations in Santa Monica Bay, including storm drains and piers. Table 2 provides a complete list of station identifications and their corresponding locations.

II. MATERIALS AND METHODS

Sample Collection

Historically, EMD monitored eighteen MS4, SMB shoreline stations ranging from Surfrider Beach (S1, Malibu Lagoon) in Malibu southward to Malaga Cove (S18, Palos Verdes Estates; Figure 1). On November 1, 2004, CLA EMD began participating in the Coordinated Shoreline Monitoring Plan (CSMP) for the Santa Monica Bay Beaches Bacterial TMDLs (SMBBB TMDL), monitoring 25 SMBBB TMDL compliance stations ranging from El Pescador State Beach in Malibu (1-2) southward to Dockweiler State Beach (stations BC-1 through 2-13). In addition to the compliance sampling sites, the CSMP established that CLA EMD would record weekly, dry-weather flow observations at five observation sites with the caveat that after a year of observations, the Regional Board would determine whether these sites would warrant being added to the list of compliance water quality sites, based on observations of persistent dry-weather runoff.

The CSMP and the Memoranda of Agreement reached between CLA and the other SMBBB TMDL responsible agencies established that CLA was responsible for monitoring 16 compliance stations solely as SMBBB TMDL stations, and 11 compliance stations as both MS4 and SMBBB TMDL sites, e.g., Malibu Creek at Surfrider Beach is both S1 and MC-2 for MS4 and SMBBB TMDL compliance monitoring, respectively (Table 2). MS4 and SMBBB TMDL stations are monitored either daily (Monday – Saturday) or weekly. In addition to adopting some MS4 stations as TMDL stations, some TMDL monitoring requirements were incorporated into the MS4 permit. Accelerated monitoring of weekly monitored TMDL stations is conducted 48 hours after the initial sample exceeds bacterial standards and 96 hours for sites that again exceed bacterial limits.

CLA submitted a request to the Regional Board in September of 2009 recommending the upgrade of two observation stations with persistent runoff and either the removal or re-location of sampling locations that were consistently inaccessible to sampling and/or observations. In December 2009, the Regional Board approved CLA's proposed changes. Observation stations O-1 (Zumirez Dr, Point Dume) and O-2 (Puerco Canyon SD, Puerco Beach) were upgraded to bacterial water quality monitoring stations based on persistent runoff to sampling stations and accessibility; station O-3 (Pierda Gorda, 36" SD) was removed as an observation site due to its continued inaccessibility. In addition, as a consequence of constant inaccessibility and a safety concern to field personnel, 2-1 (Castlerock SD) was relocated from point zero to just north of the storm drain where it is accessible and safe to sample. It was re-designated 2-1a to reflect the change in sampling point. The approved changes became effective January 2010, and EMD began sampling 27 SMBBB TMDL compliance monitoring stations and continued recording dry-weather flow observations at the two remaining observation sites: O-4 and O-5.

With the exception of a few sites, all shoreline stations are sampled at point zero, which is defined as the point at which the discharge from a storm drain or creek initially mixes with the receiving water. A station having no storm drain or creek associated with it is referred to as an open beach site and is sampled at the midpoint of the beach (CSMP 2004). Station 2-1 (Castlerock SD), which was relocated from point zero to just north of the storm drain in January 2010, also is not sampled at point zero.

Station Location	Station Name	Frequency	Station Location	Station Name	Frequency
El Pescador SB	1-2	Weekly	Santa Ynez SD, Will Rogers SB	2-2	Weekly
El Matador SB	1-3	Weekly	Pulga Cyn SD, Will Rogers SB	2-4	Weekly
Zumirez Dr, Point Dume	O-1	Weekly	Santa Monica Cyn SD, Santa Monica SB	2-7	Daily
Walnut Creek, Paradise Cove	1-6	Weekly	Santa Monica Pier SD, Santa Monica SB	3-3	Daily
Escondido Crk, Escondido SB	1-8	Weekly	Pico-Kenter SD, Santa Monica SB	3-4	Daily
Solstice Crk, Dan Blocker County Bch	1-10	Weekly	Ashland SD, Santa Monica SB	3-5	Daily
Marie Cyn SD, Puerco Bch	1-12	Weekly	Rose Ave SD, Venice Bch	3-6	Weekly
Puerco Canyon SD, Puerco Bch	O-2	Weekly	Windward Ave SD, Venice Bch	3-8	Weekly
Malibu Crk, Malibu Lagoon County Bch	MC-2	Daily	Ballona Creek, Dockweiler SB	BC-1	Daily
Sweetwater Cyn SD, Carbon Bch	1-13	Weekly	Culver SD, Dockweiler SB	2-10	Weekly
Las Flores Crk, Las Flores SB	1-14	Weekly	North Westchester SD, Dockweiler SB	2-11	Weekly
Pena Crk, Las Tunas County Bch	1-16	Weekly	Imperial Hwy SD, Dockweiler SB	2-13	Weekly
Tuna Cyn, Las Tunas County Bch	1-17	Weekly	24" corrugated metal pipe near O-5	O-4	Weekly
Topanga Cyn, Topanga County Bch	1-18	Daily	Marquez SD, Santa Ynez subwatershed	O-5	Weekly
Castlerock SD, Topanga County Bch	2-1	Weekly			

Table 2. Summary of CLA EMD's bacterial compliance monitoring stations in Santa Monica Bay with corresponding MS4 and/or SMBBB TMDL station identification. Sampling frequency is daily or weekly; NS = not sampled. Sampling at El Pescador State Beach (1-2) ceased due to safety concerns; sampling will resume when safety issues are resolved. Stations SMB-O-4 and O-5 are monitored only as dry-weather flow observations sites.

All samples were collected at ankle-depth during daylight hours, with the exception of station 2-2. Accessing 2-2 is difficult; there is a tall fence surrounding the storm drain, large boulders in both directions, and a "Keep off Rocks" sign. Sampling is attainable from the top of the storm drain, but a point zero (mixed) sample can be collected only at high tide. The location of station 1-17 poses an accessibility obstacle as it is reachable only through a very narrow stretch of private beach; during high tide and/or when rocks pose a safety risk to field personnel, this site is inaccessible. In September 2011, sampling at El Pescador State Beach (1-2) ceased due to safety concerns to field personnel; sampling will resume when safety issues, such as eroding and unstable terrain, are resolved.

Because of spatial, logistical, and time constraints, simultaneous sample collection (within a 3 – 4 hour period) of SMB TMDL and MS4 stations is divided into northern stations, from 1-2 (El Pescador State Beach) to 1-16 (Pena Creek), central stations, from 1-17 (Tuna Canyon) to 3-8 (Windward Ave) in Venice Beach, and southern stations, BC-1 (Ballona Creek) to 2-13 (Imperial Hwy) in Dockweiler State Beach.

For FY2013-2014, 2,708 samples were collected for the MS4 and SMBBB TMDL Programs combined.

Sample Analysis

Total coliform (TC) and *E. coli* (EC) bacterial densities were determined by the chromogenic substrate method following Standard Methods section 9223 and *Enterococcus* (ENT) densities were determined by Standard Methods 9230D (APHA 2012). Fecal indicator bacterial analyses totaling 8,124 were performed during the 2013 – 2014 fiscal year.

Visual field observations for shoreline stations were made along a 20-foot stretch of shoreline up and down coast of each station. This area around each station was observed for the presence of materials of sewage and non-sewage origin, any unusual odors of sewage and non-sewage origin, plankton color, and the presence of flow and flow rate (visual rating only) from storm drains and creeks. Storm drain flow data and Low-Flow Diversion structures operation information is available upon request. Materials of sewage origin include plastic goods, rubber goods, and grease particles. Non-sewage origin materials include ocean debris, seaweed, refuse, tar, and dead marine animals. Station 3-5 (S7, Ashland SD, Santa Monica State Beach) was used as the shoreline weather station for observations of air and water temperature, weather conditions, wind speed and direction, wave height, and sea conditions.

Quality assurance and quality control procedures were conducted to confirm the validity of the analytical data collected. All areas impacting reported data were subjected to standard microbiological quality control procedures in accordance with Standard Methods (APHA 1998). These areas include sampling techniques, sample storage and holding time, facilities, personnel, equipment, supplies, media, and analytical test procedures. Duplicate analyses also were performed on ten percent of all samples. When quality control results were not within acceptable limits, corrective action was taken. This quality assurance program helped ensure the production of uniformly high quality and defensible data. In addition, EMD participates annually in the performance evaluation program managed by the California State Department of Public Health (CSDPH) as part of its Environmental Laboratory Accreditation Program (ELAP); CSDPH biennially certifies EMD.

Data Analysis

The results obtained from microbiological samples do not generally exhibit a normal distribution. To compensate for a skewed distribution and to obtain a nearly normal distribution, data was log-normalized prior to analysis. Geometric means are the best estimate of central tendency for log-normalized data and were calculated for each bacterial indicator group for all sampling sites. Geometric means were categorized into summer-dry, winter-dry, and wet-weather to examine the effects of runoff from storm drains on indicator bacterial concentrations.

The geometric mean is defined in Webster's Dictionary as "the n^{th} root of the product of n numbers." The SMBBB TMDL rolling 30-day geometric mean was calculated as the 30^{th} root of the product of 30 numbers (the most recent 30-day results). For weekly sampling, the 30 numbers are obtained by assigning the weekly test result to the remaining days of the week. If more samples are tested within the same week, each test result superseded the previous result and was assigned to the remaining days of the week until the next sample was collected. A rolling 30-day geometric mean was calculated for each day, regardless of whether a weekly or daily schedule was selected, during summer-dry and winter-dry periods.

The SMBBB TMDLs define wet-weather as days with rain events of ≥ 0.1 inch of precipitation and the three days following the end of the rain event. Rain data were obtained from the National Weather Service’s Downtown Los Angeles, University of Southern California (USC) records.

III. RESULTS

Rainfall

Rainfall recorded during Fiscal Year 2013-2014 totaled 6.08 inches, which is more than FY 2012-2013 (5.84 inches), but well below the seasonal average (15.14 inches) for the Los Angeles area. This also was the third lowest rainfall year for the region in the last ten years. November 2013 to April 2014 were the primary months of rainfall for the FY 2013-2014. February and March had the most rainfall totaling 4.76 inches. February received the highest rainfall (3.58 inches) and October had the lowest measureable precipitation (0.06 inch) for this reporting period. No rain was recorded for the months for June, August and September 2013, and January and May 2014 (Figure 2).

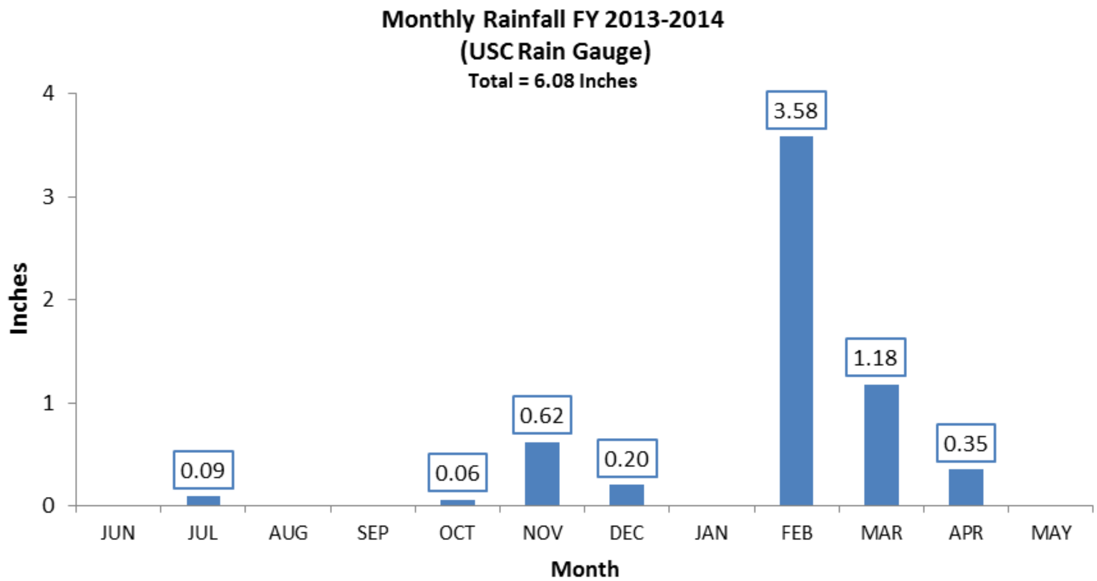


Figure 2. Monthly rainfall at Downtown Los Angeles, USC rain gauge, June 2013 – May 2014.

Shoreline Monitoring Stations

Sample collection from Santa Monica Bay compliance monitoring stations is conducted year round to assess water quality. Bacterial densities obtained from fiscal year 2013-2014 were computed and graphed for geometric mean values for summer-dry, winter-dry, and wet-weather. Graphical representations of geometric mean values per monitoring site for each time period are illustrated in Figures 3, 4, and 5. The incorporation of sixteen SMBBB TMDL stations, in addition to the 10 historical SMB MS4 sites, variations, and significant geometric mean observations are presented below.

Summer-Dry Weather (Jun 2013 – Oct 2013; Apr 2014 – May 2014)

The highest geometric means, overall, for indicator bacteria during summer-dry periods were recorded at stations 3-3 (Santa Monica Pier),), 1-12 (Marie Canyon), and BC-1 (Ballona Creek) (Figure 3). The southern bay station BC-1 (Ballona Creek) registered the highest total coliform geometric mean. The site with the highest calculated *E. coli* densities, 3-3, is located in central Santa Monica Bay. Central bay station 3-3 recorded the highest *Enterococcus* geometric mean. Compared to FY 12-13 summer-dry periods, FY 13-14 summer-dry weather recorded lower densities for all three fecal indicator bacteria.

Winter-Dry Weather (November 1, 2013 to March 30, 2014)

High geometric means of bacterial indicators measured for the winter-dry weather were predominately at stations 3-3 (Santa Monica Pier) and BC-1 (Ballona Creek) (Figure 4). These two stations registered higher geometric means for total coliform, *E. coli* and *Enterococcus* densities. Station BC-1 had the highest geometric mean for total coliform densities. Station 3-3 had the highest geometric means for *E. coli* and *Enterococcus* densities. Geometric means for the rest of the stations were relatively low. Winter-dry geometric means were in general greater than summer-dry geometric means.

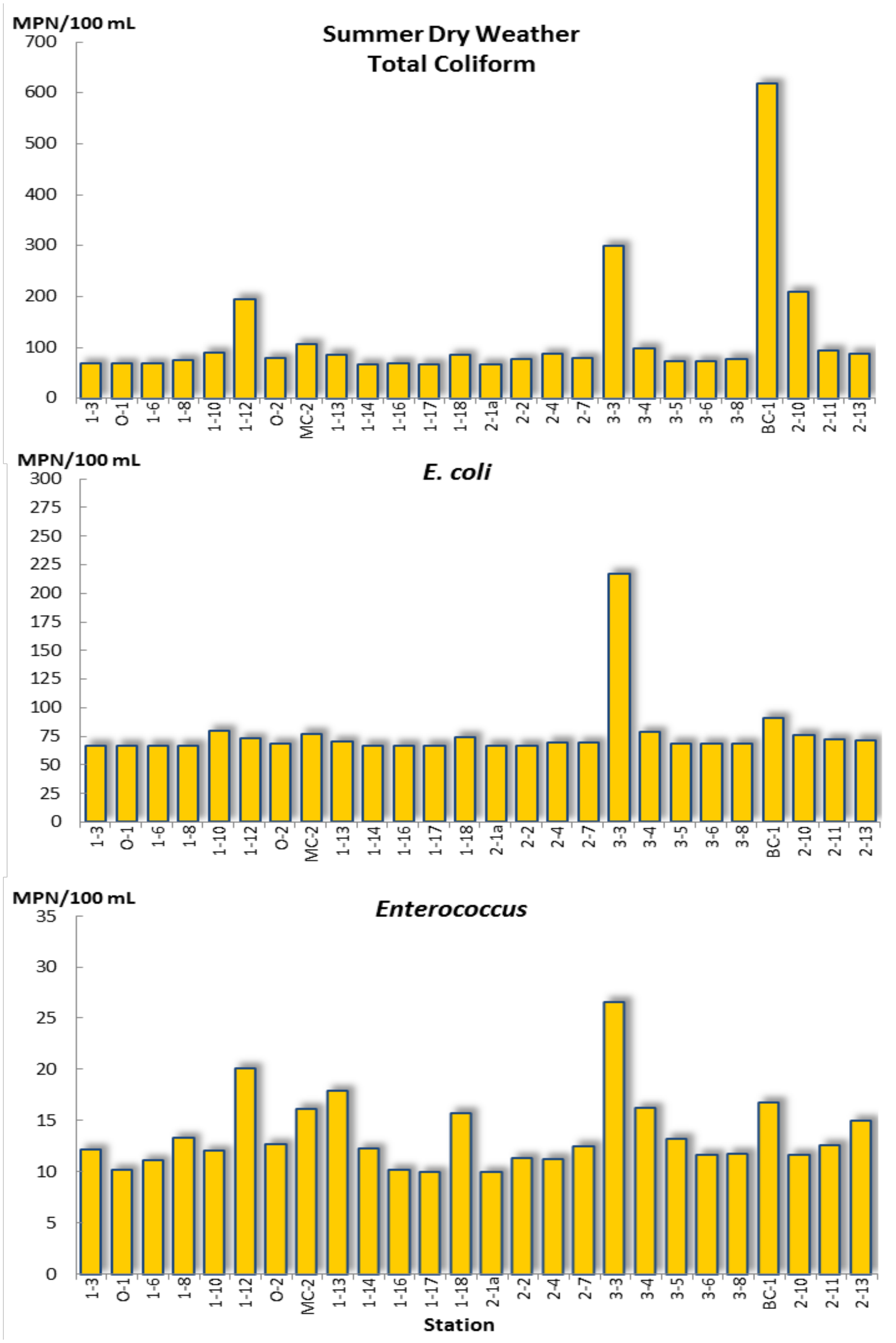


Figure 3. Summer-dry weather geometric means for indicator bacteria at compliance monitoring stations in Santa Monica Bay, FY 2013-2014.

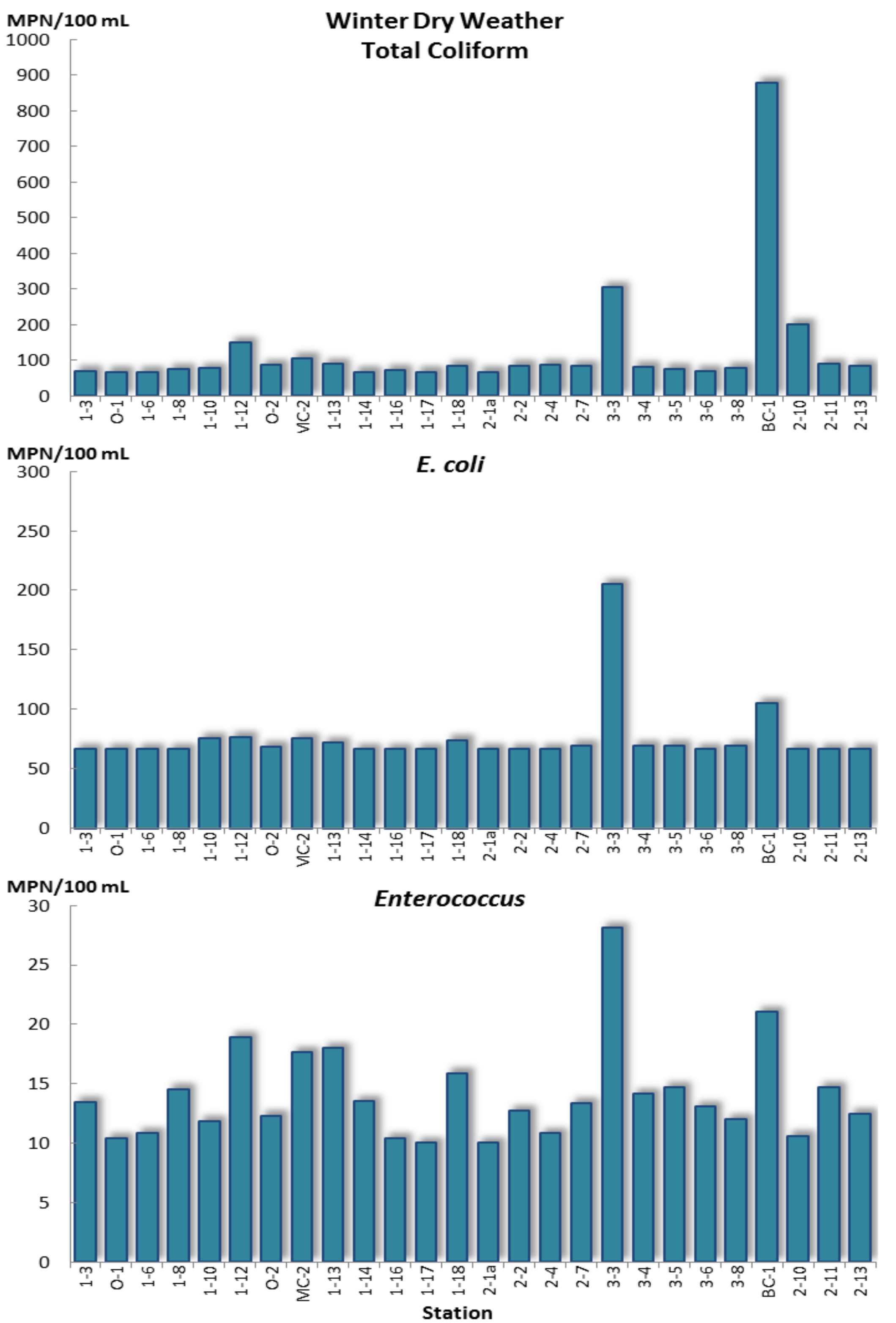


Figure 4. Winter-dry weather geometric means for indicator bacteria at compliance monitoring stations in Santa Monica Bay, FY 2013-2014.

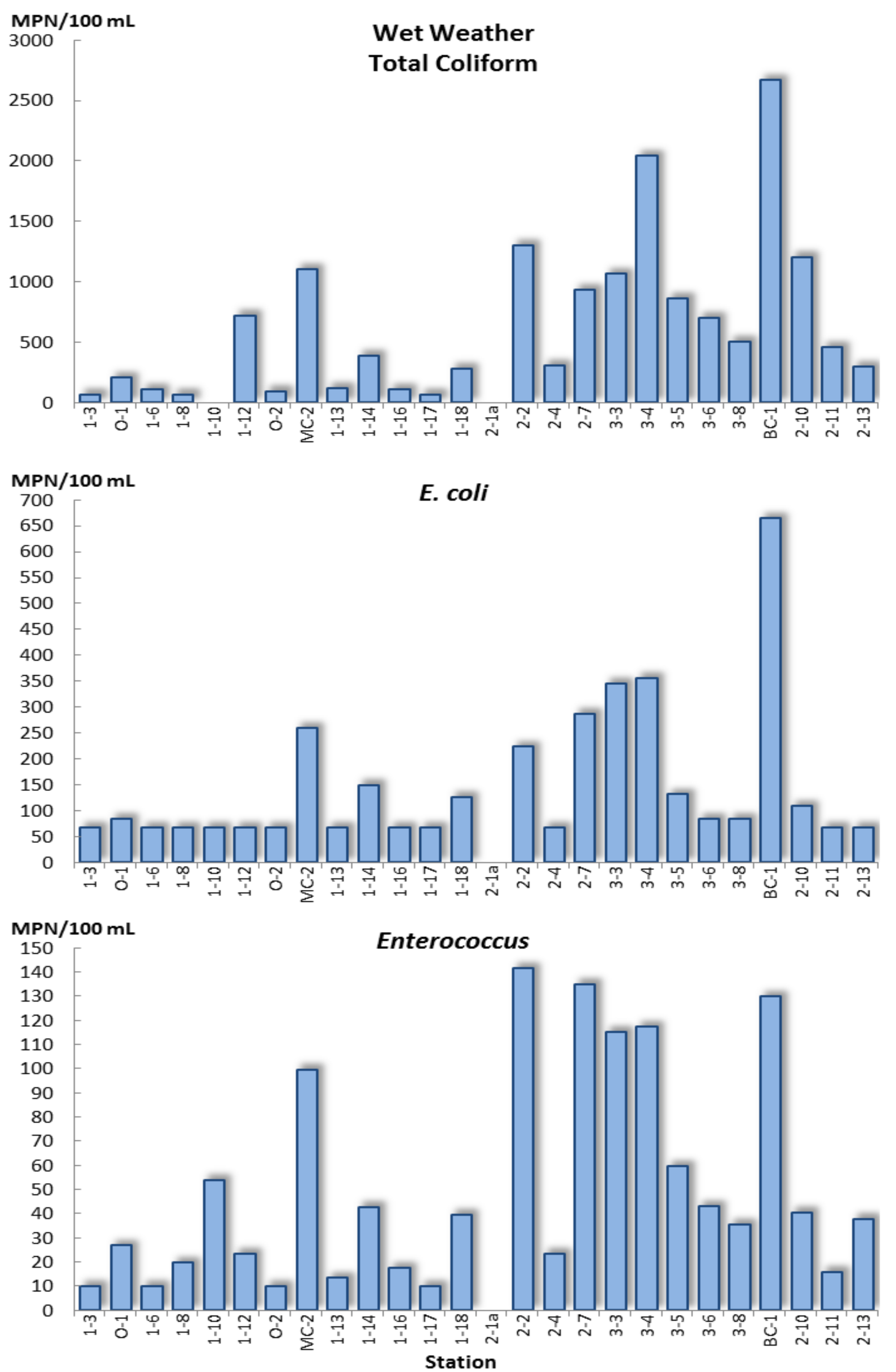


Figure 5. Wet-weather geometric means for indicator bacteria at compliance monitoring stations in Santa Monica Bay, FY 2013-2014.

Wet-Weather (Day of rain with at least 0.1 inches of rainfall plus three succeeding days)

Geometric means computed for compliance stations during wet-weather are graphically illustrated in Figure 5. Stations BC-1 and 3-4 had the highest and second highest densities, respectively, for total coliform and *E. coli* densities during wet-weather periods. Total coliform densities at BC-1 were the highest densities observed. Stations 2-2 and 2-7 had the highest *Enterococcus* geometric means. Stations MC-2, 2-2, 2-7, and 3-3 were among sites with moderate to high geometric mean levels compared to the remaining stations.

The overall geometric means recorded for wet-weather periods (Figure 5) were typically higher compared to the dry-weather periods. The majority of high bacterial indicator concentrations were detected in the central region of the Bay. The remaining stations had low geometric mean levels for the wet-weather periods.

Water Quality Standards Compliance

Per the Santa Monica Bay Beaches Bacteria TMDL, allowable exceedance days assigned to each station is adjusted on the basis of the monitoring frequency; fewer exceedances are allocated for sites monitored weekly, compared to those that are monitored daily. During dry-weather periods when a weekly monitored station exceeds one of the water quality objectives (Table 1), accelerated monitoring is triggered, in which an additional sample is collected after 48 hours of the initial sampling event, and if the 48-hour sample also exceeds, another sample is collected after another 48 hours (or 96 hours after the initial weekly collection). No additional exceedance allowances were allocated for accelerated samples, and accelerated sample exceedances are not counted against the allowable exceedances. All exceedance days for daily monitored SMBBB TMDL sites are counted against the allowable exceedance days (Table 2).

The purpose of collecting shoreline samples and reporting bacterial densities is to determine compliance with the state bathing water standards In addition, when an exceedance of bacterial water quality standards occurs, the LACDPH takes steps to notify beach goers, such as posting health hazard warning signs. Los Angeles Basin Plan bacteriological objectives for REC-1 designation for FY 2013-2014 Santa Monica Bay shoreline stations collected by CLA EMD were examined and evaluated (Tables 3 to 6).

Summer-Dry Weather (Jun 2013 – Oct 2013; Apr 2014 – May 2014)

Of the 26 shoreline stations monitored for SMBBB TMDL compliance, 17 stations surpassed the single-sample waste load allocation (WLA) of zero allowable exceedances during the summer-dry period (Table 3), whereas only 6 stations surpassed the rolling, 30-day geometric mean limit of zero allowable exceedance days. Stations 3-3, 3-4, MC-2, 1-18, and BC-1 had the highest TMDL single-sample exceedance days amongst the stations monitored daily; stations 1-12 had the highest single-sample TMDL exceedance days for weekly monitored stations. With the exception of station 1-18, all aforementioned TMDL stations had the highest rolling 30-day geometric-mean exceedance days; overall, station 3-3 had the highest rolling 30-day geometric mean exceedance days. Analyzing the data in terms of single-sample exceedance rate (% exceedance), only two daily monitored TMDL stations had exceedance rate greater than 10%; stations 3-3 at 38% and BC-1 at 14%. Weekly TMDL station 1-12 had a 13% exceedance rate.

Table 3. Summer-Dry Weather, FY 2013-2014 Exceedance Days

Station*	Sampling Frequency	Sample Days	Single-Sample Exceedance Days	Waste Load Allocation*	Percent Single-Sample Exceednce Rate	Rolling 30-Day Geometric Mean Exceedance Days
1-3	Weekly	30	1	0	3%	0
O-1	Weekly	30	0	0	0%	0
1-6	Weekly	30	0	0	0%	0
1-8	Weekly	30	1	0	3%	0
1-10	Weekly	30	2	0	7%	0
1-12	Weekly	30	4	0	13%	15
O-2	Weekly	30	1	0	3%	0
MC-2(S1)	Daily	150	13	0	9%	34
1-13	Weekly	30	2	0	7%	0
1-14	Weekly	30	1	0	3%	0
1-16	Weekly	30	0	0	0%	0
1-17	Weekly	6	0	0	0%	30
1-18(S2)	Daily	149	9	0	6%	2
2-1a	Weekly	3	0	0	0%	0
2-2	Weekly	11	0	0	0%	0
2-4(S3)	Weekly	30	0	0	0%	0
2-7(S4)	Daily	150	5	0	3%	0
3-3(S5)	Daily	149	57	0	38%	97
3-4(S6)	Daily	149	13	0	9%	0
3-5(S7)	Daily	150	5	0	3%	0
3-6	Weekly	30	0	0	0%	0
3-8(S8)	Weekly	30	0	0	0%	0
BC-1(S10)	Daily	130	18	0	14%	79
2-10(S11)	Weekly	30	1	0	3%	0
2-11	Weekly	30	1	0	3%	0
2-13(S12)	Weekly	30	1	0	3%	0

* Waste Load Allocation is defined as allowable number of exceedance days.

Station 1-17 exceeded the rolling 30-day geometric-mean 30 times. These values can be misleading and may not represent the true water quality conditions of Tuna Canyon SD (1-17) when considering only 6 samples were collected during summer-dry periods and that zero samples exceeded water quality standards. As previously indicated, station 1-17 is frequently inaccessible and a higher number of samples may have yielded a more comprehensive representation of water quality conditions.

Overall, 23 stations (88% of monitoring sites) had an exceedance rate equal to or less than 10 percent.

In terms of analyzing exceedances per FIB (Table 6), *E. coli* and/or *Enterococcus* objectives were the standards most exceeded amongst all compliance monitoring sites. Station BC-1 had the highest total coliform exceedances. Station 3-3 had the highest *E. coli* and *Enterococcus* exceedances. .

Winter-Dry Weather (November 1 – March 31)

SMBBB TMDL compliance stations monitored during winter-dry weather are allocated higher allowable exceedances days compared to summer-dry periods (Table 4). Thus, fewer TMDL stations (eleven) exceeded their WLA during winter-dry periods. Stations 3-3 and MC-2 had the highest TMDL single-sample exceedance days and rolling 30-day geometric mean exceedance days among daily sampled stations. Single-sample exceedance rate computed for station 3-3 (56%) was the highest rate observed for this winter dry-weather period. Station MC-2 had the second highest single-sample exceedance rate at 28%. Stations 1-12, 1-14, 2-2, and 2-13 (Imperial Highway SD) had the highest exceedances for the weekly monitored TMDL stations. Station 2-2 yielded a 50% single-sample exceedance rate and a rolling 30-day geometric mean exceedance of 17 days. However, the high exceedance rate observed at station 2-2 can be misleading, considering this site is frequently inaccessible to sampling; samples were collected 6 out of a minimum 14 possible weekly sampling days. Stations 1-12 and 1-14 had 21% and 16% single-sample exceedance rates, respectively. Stations 1-3, 1-10, O-2, 1-16, 1-17, 2-1a, 2-4, and 3-8 did not exceed on any monitoring day. Generally, single-sample exceedance rates recorded for weekly monitoring stations were lower than exceedance rates obtained from daily sampling stations.

Exceedances per indicator evaluated for winter-dry weather are summarized in Table 6. Stations 3-3 and BC-1 had the highest total number of indicator exceedances, corresponding to the high exceedance days and exceedance rates observed at these sites. Station 3-3 exceeded more often for *E. coli*, and station BC-1 exceeded more often for total coliform standards. In a virtual mirror image to summer-dry weather periods, 3-3 exceeded total coliform standards twice while registering the highest percent single-sample exceedance rate for a daily-sampled TMDL station (Table 3 and Table 4). *E. coli* and *Enterococcus* were generally the indicators that exceeded most frequently for this winter dry period (Table 6).

Table 4. Winter-Dry Weather, FY 2013-2014 Exceedance Days

Station*	Sampling Frequency	Sample Days	Single-Sample Exceedance Days	Waste Load Allocation*	Percent Single-Sample Exceednce Rate	Rolling 30-Day Geometric Mean Exceedance Days
1-3	Weekly	18	0	1	0%	0
O-1	Weekly	18	1	1	6%	0
1-6	Weekly	18	1	1	6%	0
1-8	Weekly	19	1	1	5%	0
1-10	Weekly	19	0	1	0%	0
1-12	Weekly	19	4	1	21%	21
O-2	Weekly	20	0	1	0%	15
MC-2(S1)	Daily	92	26	3	28%	71
1-13	Weekly	19	1	1	5%	0
1-14	Weekly	19	3	1	16%	0
1-16	Weekly	18	0	1	0%	0
1-17	Weekly	3	0	1	0%	0
1-18(S2)	Daily	92	17	3	18%	7
2-1a	Weekly	3	0	1	0%	0
2-2	Weekly	6	3	1	50%	17
2-4(S3)	Weekly	18	0	1	0%	0
2-7(S4)	Daily	92	14	3	15%	27
3-3(S5)	Daily	91	51	3	56%	138
3-4(S6)	Daily	91	14	3	15%	12
3-5(S7)	Daily	92	5	3	5%	0
3-6	Weekly	18	1	1	6%	0
3-8(S8)	Weekly	18	0	1	0%	0
BC-1(S10)	Daily	79	11	3	14%	7
2-10(S11)	Weekly	19	1	1	5%	0
2-11	Weekly	19	1	1	5%	0
2-13(S12)	Weekly	19	2	1	11%	5

* Waste Load Allocation is defined as allowable number of exceedance days.

Wet Weather

TMDL stations BC-1, 3-3, 3-4, MC-2, and 2-7 had the highest single-sample exceedance days among daily-sampled stations during the wet-weather period; however, no stations exceeded its wet-weather WLA. Single-sample exceedance rates of 71%, 63%, 63%, 58%, and 53% were recorded at the aforementioned stations, respectively. Weekly monitored TMDL station with the highest single-sample exceedance rate was station 2-2 with an exceedance rate 50% (Table 5). However, again this is deceptive, as it was accessible to monitoring only twice during wet weather. Most weekly stations had exceedance rates of 0%, meaning all samples for these stations passed water quality objectives; the remaining stations had exceedance rates of 25 - 50%. Overall, single-sample exceedance rates are lower during this wet-weather period than previous wet-weather periods, which is consistent with the observed lower rainfall for this period.

Table 5. Wet-Weather, FY 2013-2014 Exceedance Days

Station*	Sampling Frequency	Sample Days	Single-Sample Exceedance Days	Waste Load Allocation*	Percent Single-Sample Exceednce Rate
1-3	Weekly	3	0	3	0%
O-1	Weekly	3	1	3	33%
1-6	Weekly	3	0	3	0%
1-8	Weekly	3	0	3	0%
1-10	Weekly	4	1	3	25%
1-12	Weekly	3	1	3	33%
O-2	Weekly	2	0	3	0%
MC-2(S1)	Daily	19	11	17	58%
1-13	Weekly	4	0	3	0%
1-14	Weekly	3	1	3	33%
1-16	Weekly	3	0	3	0%
1-17	Weekly	1	0	3	0%
1-18(S2)	Daily	19	6	17	32%
2-1a	Weekly	0	0	3	0%
2-2	Weekly	2	1	3	50%
2-4(S3)	Weekly	3	0	3	0%
2-7(S4)	Daily	19	10	17	53%
3-3(S5)	Daily	19	12	17	63%
3-4(S6)	Daily	19	12	17	63%
3-5(S7)	Daily	19	5	17	26%
3-6	Weekly	3	1	3	33%
3-8(S8)	Weekly	3	0	2	0%
BC-1(S10)	Daily	17	12	17	71%
2-10(S11)	Weekly	3	1	3	33%
2-11	Weekly	3	0	3	0%
2-13(S12)	Weekly	3	1	3	33%

* Waste Load Allocation is defined as allowable number of exceedance days.

In recognition that urban and stormwater runoff conveyed by storm drains and creeks is a primary source of elevated bacteria, the SMBBB TMDL allocates a greater number of single-sample exceedance days during wet-weather (Table 5) compared to dry-weather periods, acknowledging higher runoff volume during wet weather. No TMDL stations, compared to eleven and seventeen for winter-dry and summer-dry periods, respectively, exceeded their WLA. Sampling sites collected during wet-weather are not subject to rolling 30-day geometric mean compliance requirements.

Stations 3-3, 3-4, and BC-1 had the top three highest numbers of exceedances for all water quality objectives combined. Station BC-1 had the highest exceedances for total coliform, 3-3 had the highest number of *E. coli* exceedances (Table 6). Monitoring sites 3-4, 2-7, 3-3, and MC-2 frequently exceeded water quality standards as well.

Table 6. Exceedances Per Water Quality Objectives (WQO), FY 2013-2014

	Summer-Dry					Winter-Dry					Wet-Weather				
	Exceedances Per WQO[1]				Total WQO[1] Exceedances	Exceedances Per WQO[1]				Total WQO[1] Exceedances	Exceedances Per WQO[1]				Total WQO[1] Exceedances
Station	Total[2]	E.coli[3]	Entero[4]	Ratio[5]		Total[2]	E.coli[3]	Entero[4]	Ratio[5]		Total[2]	E.coli[3]	Entero[4]	Ratio[5]	
1-3	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0
O-1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
1-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1-8	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0
1-10	0	2	0	0	2	0	1	0	0	1	0	0	1	0	1
1-12	0	1	3	1	5	0	1	2	1	4	1	0	0	0	1
O-2	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0
MC-2(S1)	0	5	8	6	19	0	2	6	2	10	2	8	10	7	27
1-13	0	0	2	0	2	0	0	1	0	1	0	0	0	0	0
1-14	0	0	1	0	1	0	0	1	0	1	1	1	1	0	3
1-16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1-17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1-18(S2)	0	1	8	0	9	0	1	4	0	5	2	3	4	1	10
2-1a	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-2	0	0	0	0	0	0	0	0	0	0	1	1	1	0	3
2-4(S3)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2-7(S4)	0	1	4	0	5	0	1	4	0	5	7	8	10	5	30
3-3(S5)	2	52	13	19	86	2	27	9	12	50	3	10	8	6	27
3-4(S6)	1	5	12	4	22	0	0	3	1	4	9	8	9	5	31
3-5(S7)	0	1	4	0	5	0	1	4	0	5	4	4	5	2	15
3-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-8(S8)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BC-1(S10)	12	9	8	5	34	11	9	8	5	33	10	9	9	7	35
2-10(S11)	1	1	0	0	2	0	0	0	0	0	1	0	0	0	1
2-11	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0
2-13(S12)	0	1	1	0	2	0	0	0	0	0	0	0	1	0	1

[1]Water quality objectives (WQO) per indicator bacteria as established by the Basin Plan:

[2]*Total coliform limit is 10,000 MPN/mL*

[3]*E. coli limit is 400 MPN/mL*

[4]*Enterococcus limit is 104 MPN/mL*

[5]*Ratio of E. coli/Total coliform is greater than 0.1 when total coliform level is greater than 1,000 org./100mL*

Field Observations

Field observations were recorded for each sampling location and normally were rated using an EMD historical standard rating system, 1=low, 2=moderate, and 3=high. Observations include the materials of sewage origin (MOSOs) or non-sewage origin, any unusual odors of sewage or non-sewage origin, and flow and flow rate (visual rating only) from storm drains, streams, debris, seaweed, tar, and plankton, among others.

Materials of Sewage Origin

Observations of materials of sewage origin (MOSOs), such as plastic goods (tampon inserts), rubber goods (prophylactic rings), and grease particles were recorded during Fiscal Year 2013-2014. There were no incidences of observed MOSOs in Santa Monica Bay for the entire fiscal year.

Storm Drain Flows

Non-point source pollution has been estimated to be the leading cause of water quality deterioration (EPA 2010). Originating from inland, these pollutants are washed into creeks, streams, rivers, and storm drains, which eventually reach the ocean during heavy rains. Storm drains are designed to receive urban and storm water runoff from paved streets, parking lots, sidewalks, and roofs. Urban and storm water runoff, carried to the Bay through the region's massive storm drain systems and few remaining streams, is a serious, year-round concern (Santa Monica Bay Restoration Commission 2008). For the 26 EMD-monitored sampling stations along the Santa Monica Bay shoreline, 15 stations are associated with storm drain outfalls, 1 station is located at a pier, 6 stations are associated with creeks, 1 station is an open beach site, and 2 sites are associated with a lagoon.

A summary of storm drain flow data obtained from CLA EMD Santa Monica Bay monitoring sites during FY 2013-2014 is presented in Table 7.

Low-Flow Diversion Devices (LFDs):

Twelve SMB compliance stations and one observation site, O-5, monitored by CLA EMD are associated with low-flow diversion devices (LFDs). The cities of Los Angeles and Santa Monica and the County of Los Angeles operate a total of 23 LFDs along the Santa Monica Bay shoreline from Castlerock to Dockweiler State Beach, which as of November 1, 2009, began operating during year-round dry weather. These devices are installed at the major storm drain outfalls to prevent dry-weather runoff from reaching the Santa Monica Bay beach shoreline by diverting the flows to the sanitary sewer collection system for treatment at the Hyperion Wastewater Treatment Plant (Table 7 and Figure 6).

Table 7. Storm Drain flow data for MS4, SMB TMDL stations and observation sites, FY 2013-2014.

Station	Location	LFD In Place	Summer Dry		Winter Dry		Wet Weather	
			% Observed Flow Days	Avg. Flow[1]	% Observed Flow Days	Avg. Flow[1]	% Observed Flow Days	Avg. Flow[1]
1-3	Open Beach	-	0	0	0	0	0	0
O-1	Creek	No	107	1	89	1	100	1
1-6	Creek	No	50	3	6	1	67	1
1-8	Creek	No	35	4	0	0	0	0
1-10	Creek	No	38	3	16	1	50	2
1-12	Storm Drain	No	129	1	95	2	100	2
O-2	Storm Drain	No	31	1	33	1	0	0
MC-2	Lagoon	No	10	3	66	3	58	3
1-13	Storm Drain	No	42	1	50	1	60	1
1-14	Creek	No	39	3	11	1	33	3
1-16	Creek	No	0	0	0	0	0	0
1-17	Canyon	No	18	1	10	1	24	2
1-18	Lagoon	No	43	4	8	2	16	2
2-1	Storm Drain	Yes	0	0	0	0	0	0
2-2	Storm Drain	Yes	7	0	4	1	42	2
2-4	Storm Drain	Yes	13	0	11	1	0	0
2-7	Storm Drain[2]	Yes	43	4	0	0	37	2
3-3	Pier	Yes	5	0	0	0	11	3
3-4	Storm Drain	Yes	27	2	1	3	32	3
3-5	Storm Drain	Yes	2	1	0	0	26	2
3-6	Storm Drain	Yes	13	2	0	0	0	0
3-8	Storm Drain[2]	Yes	0	0	0	0	0	0
BC-1	Storm Drain	No	100	3	98	3	100	3
2-10	Storm Drain	Yes	0	0	0	0	0	0
2-11	Storm Drain	Yes	0	0	0	0	0	0
2-13	Storm Drain[2]	Yes	10	1	0	0	0	0

[1] *Average Flow Rate: (0)= no flow (1)=low (2)=moderate (3)=heavy*

[2] *Low Flow Diversion (LFD) owned and operated by the City of Los Angeles*

IV. DISCUSSION

Data presented herein, indicates stations 1-12 (Marie Canyon), MC-2 (Surfrider Beach, Malibu), 3-3 (Santa Monica Pier), BC-1 (Ballona Creek), and to a lesser extent to 3-4 (Pico-Kenter), as the sites, overall, that are the most impacted by pollution and consequently, the most problematic. Station 1-12 is located in front of Marie Canyon storm drain on Puerco Beach, just downstream of a treatment facility. Although data identifies 1-12 as a problematic weekly monitored site for the third consecutive year, the data also reveals a decrease in single-sample exceedances of 12 to 4 days during summer-dry weather periods compared to FY 2011-2012. The County of Los Angeles has operated a UV filtration treatment facility near this site since October 2007; it is designed to filter and treat as much as 100 gallons per minute of dry-weather runoff (LADPW 2007). Los Angeles County's treatment facility at Marie Canyon has no sewer line. Instead, the treatment facility treats stormwater through filtration, and returns the cleansed flow to the storm drain. L.A. County is working to fix issues with the filtration system, including sediment diversions to limit inefficient filtration, as well as increasing dry-weather pumping capacity.

Station MC-2, one of the sites with the poorest water quality, is located at Surfrider Beach at the outlet of the Malibu Creek watershed and is mainly affected by flows from Malibu Lagoon. Higher exceedance rates are registered in the winter and wet-weather seasons when the berm of the Lagoon is breached and flows from the Lagoon mix with the wave wash at the shoreline. The watershed where this site is located covers a large area, approximately 105 square miles. There is considerable local activity at this beach, and the lagoon serves as a habitat for numerous bird species, an added source of bacterial pollutants. Surfrider Beach previously has been identified as one of the most polluted beaches in Santa Monica Bay (CLA, EMD 2003). The U.S. Geological Survey (USGS) published results of a study to identify the distribution and sources of FIB in coastal Malibu waters (Izbicki et al., 2012). Onsite wastewater treatment systems (OWTS) in Malibu were suspected as potential sources of FIB to Malibu Lagoon and the near-shore ocean at and around Surfrider Beach; however, results from the USGS study did not support this presupposition. The authors speculated that high FIB concentrations in the Lagoon may originate from non-human fecal sources such as birds and the extended survival or regrowth of indicator bacteria. Higher FIB concentrations and a higher occurrence of exceedances during the USGS study were observed during low tides at the end of the rainy season in April 2010. CLA EMD records of visual observation data indicate the berm was breached during this period. A close inspection of the data presented in Figure 12 of the USGS article shows FIB densities generally tended to rise at high tide during the July study period at Surfrider Beach, Puerco Beach and Malibu Colony Beach. This suggests that high tides are contacting waters of the lagoon, thereby affecting shoreline water quality. Kelp and other debris along the high-tide line also may have contributed to the elevated FIB densities during the July study period.

Santa Monica Pier (3-3) houses several food concession stands, restrooms, and parking facilities, as well as a small marine aquarium, and attracts thousands of local visitors and tourists. This location is one of the ten most polluted beaches in the state for multiple consecutive years according to Heal the Bay's 2013-2014 Annual Report Card (HTB 2014). Data from fiscal years 2010-2011 and 2011-2012 demonstrate a considerable improvement in water quality near the pier compared to previous reporting periods. This was a result of multiple implementation projects by the City of Santa Monica to reduce elevated fecal bacterial levels near the pier; these include replacement of a faulty storm drain under the pier to reduce runoff flows onto the beach, upgrades to the pier's storm drain dry-weather runoff diversion system (LFD), and several measures to reduce excessive bird populations at the pier in an effort to mitigate bird feces as a contributing source of bacterial contamination (HTB 2014; CSM 2010a and 2010b). Netting under the pier was installed to keep pigeons and other birds from nesting underneath the pier. These improvements were completed under the Santa Monica Pier improvement projects, funded by CBI and/or by Santa Monica voter-approved Measure V. Increases in dry-weather exceedance days during FY 2013-2014, however, suggest a trend reversal. Dry-weather periods from January to May 2013 had 50 exceedances, June to December 2013 registered 58 exceedances, whereas 50 exceedances were observed during January to May 2014 dry-weather periods. The discovery of tears within the netting suggests birds were re-nesting under the pier and may be the cause of the increased exceedances. After several attempts to repair the netting, it was replaced in February of 2014 (HTB 2014). This should help improve water quality over the next year.

Other stations that registered elevated levels of exceedances and geometric mean densities, but not to the same degree as the above mentioned sites, especially during dry-weather periods, are 1-18 (Topanga Canyon SD), 2-7 (Santa Monica Canyon SD), and 3-4 (Pico-Kenter SD). A Source Identification Pilot Program (SIPP) is currently underway at 1-18 (S2) with researchers from Stanford University, UCSB, UCLA, U.S. EPA Office of Research and Development, and the Southern California Coastal Water Resource Project (SCCWRP). They are developing and implementing sanitary survey/source tracking protocols at 12 to 16 of California's most polluted beaches, including Topanga (HTB, 2014).

V. CONCLUSION

Assessment of the FY 2013-2014 SMBBB TMDL and MS4 compliance-monitoring stations reveals an overall reduction for all seasons in the total number of single-sample exceedances; reduced from 452 in FY 2012-2013 - stations S13-S18 were eliminated due to a reduction of sampling conducted by CLA in the southern part of Santa Monica Bay. These locations currently are being monitored by Jurisdictions 5 and 6 - to 361 for this reporting year.

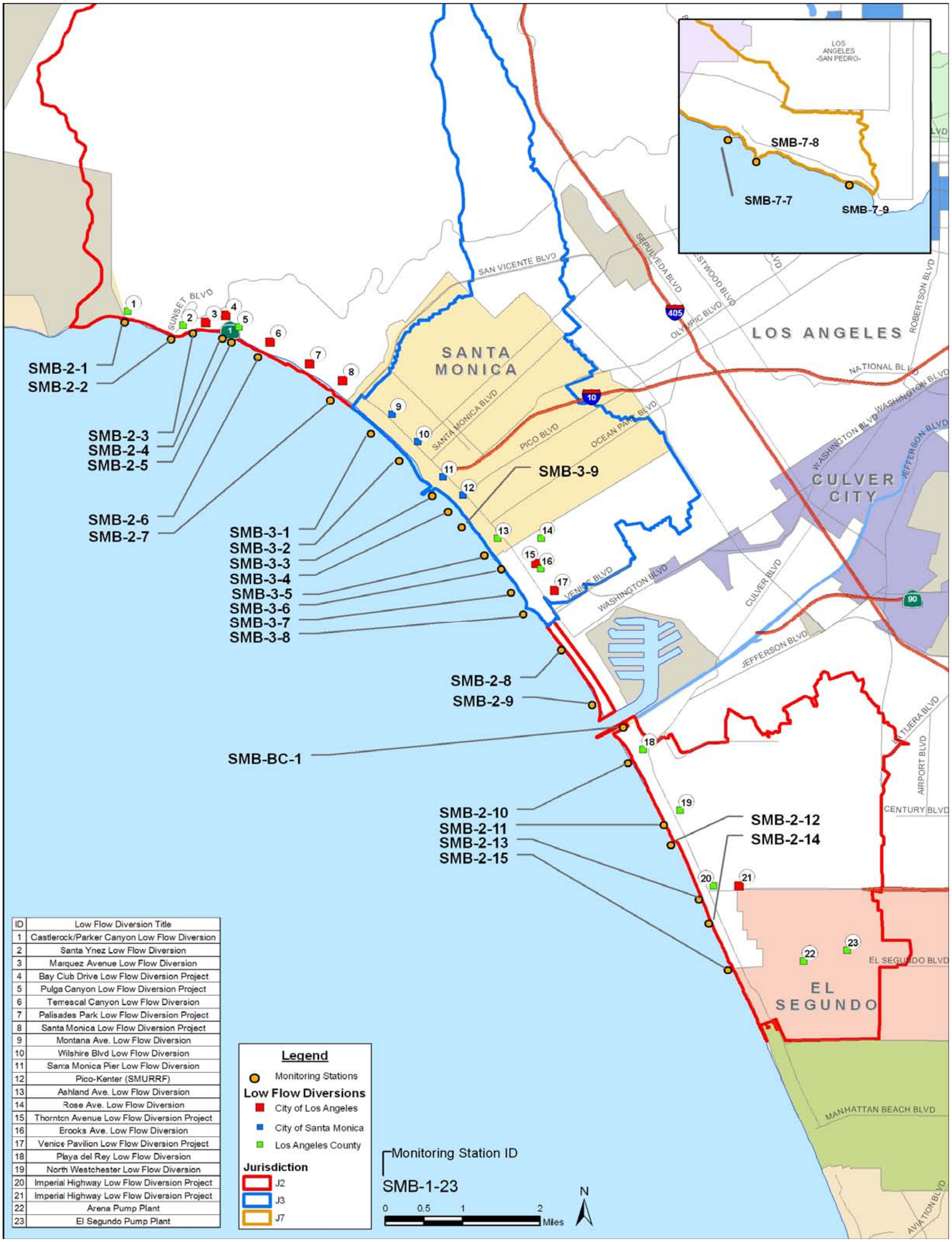
Due to constant inaccessibility, one station in particular, station 1-17 (Tuna Canyon), should be re-assessed as to the feasibility of inclusion in the monitoring program. This site was proposed for replacement or deletion by EMD in a letter to the Regional Board in September 2009. Station 1-17 was inaccessible to sampling approximately 93 percent of the time and for the days the site was accessible, there were no exceedances. This site is inaccessible to CLA EMD sample collectors during high tide events, where bacterial densities may be higher than those days when it is accessible (low tide). Although Tuna Canyon does not discharge onto a public beach, it was included in the SMB TMDLs to fulfill the requirement of having at least one compliance location in every coastal watershed (CSMP 2004). Unfortunately, as it is accessible to private beach individuals during high tide and bacterial densities are unknown for these periods, health risks also remain unknown. As is, it is not possible to get a true or better picture of water quality in this area and sampling efforts are wasted; the value of continued monitoring of this site is unknown by this agency. The removal or replacement of this site was not approved by the Regional Board.

The Santa Monica Bay Beaches Bacteria TMDL compliance deadline for the winter-dry weather period became effective on July 15, 2009. The maximum allowable exceedance days during the winter-dry weather period (November 1 – March 31) is one day for shoreline monitoring stations that are monitored on a weekly basis and three days for those with daily monitoring. The City of Los Angeles' compliance approach was to expand the operation of Low-Flow Diversions (LFDs) from the previously implemented summer-dry period (April 1 – October 31) to year-round diversion, excluding wet-weather events. Thus, as of November 1, 2009, the City, as well as the County of Los Angeles and the City of Santa Monica, began year-round operation of their LFDs. There are a total of 23 LFDs installed at major storm drain outfalls along the Santa Monica Bay shoreline within Jurisdictional groups 2 and 3 from Parker Mesa at Castle Rock to Dockweiler subwatershed; eight of the LFDs are owned and operated by the City of Los Angeles (Figure 6). Water quality within Santa Monica Bay has shown improvement in recent years due to the Low-Flow Diversion Programs, the City of Santa Monica's Urban Runoff Recycling Facility (SMURRF), and the efforts of other municipalities within the watershed in implementing several best management practices (BMPs). Heal the Bay reports that eight Santa Monica Bay beaches associated with an LFD received A or B grades this year during both summer- and winter-dry weather (HTB, 2014).

While effective for dry-weather flow, low-flow diversions are not necessarily a viable option for wet-weather flows from stormwater runoff. Most LFDs do not have the capacity to handle large volumes of runoff during wet weather (Santa Monica Bay Restoration Commission 2010), and, unfortunately, the high pollutant load of wet-weather flow has the capacity to affect beaches that routinely have good water quality. Either the capacity of flow devices must be increased to handle year-round flow, including wet-weather flows, or storm drain flows and runoff to recreational waters must be reduced.

On June 7, 2012, the Regional Board adopted revisions to multiple bacteria TMDLs in the Los Angeles Region (Basin Plan), including the SMBBB TMDLs; the State Water Resources Control Board subsequently approved the Basin Plan amendments March 19, 2013. In 2002, the Regional Board originally adopted a bifurcated SMBBB TMDL, one for dry weather and one for wet weather. The amended 2012 Basin Plan establishes a single SMBBB TMDL addressing both compliance periods. These Basin Plan amendments were approved by the State Water Board on March 19, 2013 (Resolution No. 2013-0008), approved by the Office of Administrative Law (OAL) on November 7, 2013 (2013-0927-03S), and also received approval from the U.S. Environmental Protection Agency (U.S. EPA) on July 2, 2014.

A few of the amendments that affect compliance monitoring and reporting include modification to the procedure for calculating the rolling geometric mean, removal of station BC-1 as a compliance site for SMBBB TMDL, and new WLA for winter-dry weather. The current rolling 30-day geometric means, which are calculated daily, shall be replaced by new rolling geometric means that will be calculated weekly using 5 or more samples for six-week periods, starting all calculation weeks on Sunday. As a result of the adoption of the Ballona Creek, Ballona Estuary, and Sepulveda Channel Bacteria TMDL (BCB TMDL), BC-1 was removed as a compliance monitoring station for the SMBBB TMDL by the recently reissued MS4 permit (CRWQCB, 2012 TMDLs) and will not be included in future reports.



ID	Low Flow Diversion Title
1	Castlerock/Parker Canyon Low Flow Diversion
2	Santa Ynez Low Flow Diversion
3	Marquez Avenue Low Flow Diversion
4	Bay Club Drive Low Flow Diversion Project
5	Pulga Canyon Low Flow Diversion Project
6	Temescal Canyon Low Flow Diversion
7	Palisades Park Low Flow Diversion Project
8	Santa Monica Low Flow Diversion Project
9	Montana Ave. Low Flow Diversion
10	Wilshire Blvd Low Flow Diversion
11	Santa Monica Pier Low Flow Diversion
12	Pico-Kenter (SMURRF)
13	Ashland Ave. Low Flow Diversion
14	Rose Ave. Low Flow Diversion
15	Thornton Avenue Low Flow Diversion Project
16	Brooks Ave. Low Flow Diversion
17	Venice Pavilion Low Flow Diversion Project
18	Playa del Rey Low Flow Diversion
19	North Westchester Low Flow Diversion
20	Imperial Highway Low Flow Diversion Project
21	Imperial Highway Low Flow Diversion Project
22	Arena Pump Plant
23	El Segundo Pump Plant

Figure 6. Low-Flow Diversions (LFDs) devices operated by City of Los Angeles, County of Los Angeles, and the City of Santa Monica along the Santa Monica Bay shoreline from Parker Mesa at Castle Rock to Dockweiler subwatershed.

At the inception of the SMBBB TMDL Coordinated Shoreline Monitoring Plan (CSMP), MS4 shoreline compliance stations were adopted into the CSMP and have served dual roles as MS4 and TMDL monitoring sites. A new winter-dry weather exceedance rate at the reference beach, Leo Carillo, calculated from point zero data collected from November 2004 to October 2010 will increase the final allowable exceedance days for the majority of SMBBB TMDL compliance sites during winter-dry weather. Sites with no change in WLA or that were assigned fewer allowable exceedance days are subject to anti-degradation in which there is no degradation of existing water quality allowed if historical water quality at a particular site is better than the designated reference site.

VI. LITERATURE CITED

APHA. See American Public Health Association.

American Public Health Association. 2012. Standard methods for the examination of water and wastewater, 22nd ed. American Public Health Association, Washington, DC, pp. 9-1 to 9-115.

CLA, EMD. See City of Los Angeles, Environmental Monitoring Division.

CRWQCB. See California Regional Water Quality Control Board

CSM. See City of Santa Monica, Public Works.

CSMP. See City and County of Los Angeles, Technical Steering Committee.

California Regional Water Quality Control Board, Los Angeles Region. 2001. Municipal Separate Storm Sewer System NPDES Permit. pp. 58-59.

California Regional Water Quality Control Board, Los Angeles Region. 2004. Santa Monica Bay Beaches Bacteria TMDLs, Attachment A to Resolution No. 02-400.

California Regional Water Quality Control Board, Los Angeles Region. 2012. Municipal Separate Storm Sewer System NPDES Permit.

California Regional Water Quality Control Board, Los Angeles Region. 2012. TMDLs, http://www.waterboards.ca.gov/losangeles/board_decisions/basin_plan_amendments/technical_documents/90_New/Revised/Response%20to%20Comments%20Beach%20Bact%20TMDLs%20Reopener%2024May12_final.pdf. No. 1.23

City of Los Angeles, Environmental Monitoring Division. 2003. Marine Monitoring in Santa Monica Bay: Biennial Assessment Report for the Period of January 2001 through December 2002. Report submitted to EPA and RWQCB (Los Angeles). Department of Public Works, Bureau of Sanitation, Hyperion Treatment Plant, Playa del Rey, California, pp. 1-1 to 8-37 + appendices.

City and County of Los Angeles, Technical Steering Committee. 2004. Santa Monica Bay Beaches Bacterial TMDLs Coordinated Shoreline Monitoring Plan, pp. 1-3 to 4-10 + appendices.

City of Santa Monica, Public Works. 2010a. Pier Storm Drain Improvements. http://www.smgov.net/Departments/PublicWorks/ContentCivEng.aspx?id=9630.

City of Santa Monica, Public Works 2010b. Pier Water Quality Improvement. http://www.smgov.net/Departments/PublicWorks/ContentCivEng.aspx?id=9640.

Csuros, M and C. Csuros. 1999. Microbiological examination of water and wastewater. CRC Press, Boca Raton, Florida, 360 pp.

Dojiri, M., M. Yamaguchi, S.B. Weisberg, and H.J. Lee. 2003. Changing anthropogenic influence on the Santa Monica Bay Watershed. Marine Environmental Research, 56(2003): 1-14.

EPA. See Environmental Protection Agency

Environmental Protection Agency. 2010. Polluted Runoff: Nonpoint Source Pollutions. http://www.epa.gov/nps/whatis.html

HTB. See Heal the Bay

Heal the Bay. 2014. Heal the Bay's 2013-2014 Annual Beach Report Card. http://brc.healthebay.org/assets/pdfdocs/brc/annual/2012/HtB_BRC_Annual_2014_Report.pdf

Izbicki, J. A., Swarzenski, P. W., Burton, C. A., Van DeWerfhorst, L. C., Holden, P. A., Dubinsky, E. A. 2012. Sources of Fecal Indicator Bacteria to Groundwater, Malibu Lagoon and the Near-Shore Ocean, Malibu, California, USA. Annals of Environmental Science, Vol 6, 35-86.

LACSD. See Los Angeles County Sanitation Districts.

LADPW. See Los Angeles County Department of Public Works.

Los Angeles County Department of Public Works. 2007. New Water Treatment System Targets Bacteria at One of the State's "Worst" Beaches for Water Quality. http://ladpw.org/apps/news/pdf/2380_2627.pdf.

Ohio State University. 2009. FactSheet. Non-point Source Water Pollution. AEX-44-00. Agricultural. Engineering. 590 Woody Hayes Dr., Columbus, Ohio, 43210.

Santa Monica Bay Restoration Commission. 2008. www.santamonicabay.org/smbay/ProblemsSolutions/WaterQuality/tabid/67/Default.aspx

Santa Monica Bay Restoration Commission. 2010. State of the Bay 2010 Report. Focus On Water Quality. http://santamonicabay.org/smbay/NewsEvents/StateoftheBay/StateoftheBayReport/tabid/176/Default.aspx

Schiff, K. and P. Kinney. 2001. Tracking sources of bacterial contamination in stormwater discharges from Mission Bay, California. http://www.sccwrp.org/pub/download/DOCUMENTS/AnnualReports/1999AnnualReport/07_ar06.p